

**SECRET**

*Panda*  
AB 1007-36051

16378A

**SECRET**

12 November 1947

MEMORANDUM FOR THE ASSISTANT DIRECTOR FOR REPORTS AND ESTIMATES

Subject: Transmission of Report

There are transmitted herewith for the information and retention of JRDB three pages translated from the Russian. These pages contain the available portion of a description of a ship engine (combination turbine) under development by the USSR. It is thought that this material may be of interest to JRDB.

JRDB's reaction to the technical value of the subject report is requested.

|  |
|--|
|  |
|  |

25X1

25X1

25X1

|  |
|--|
|  |
|--|

Attachments (3 pages)

**REFERENCE CENTER LIBRARY**

**SECRET**

*evaluated*  
m

Internal combustion turbine

SECRET

Interchanger of heat for trip grade #3

36051

Interchanger of heat

Weight of the air and gas

9,75 kg per second

Release temperature of the escaping gases from the last turbine grade

 $t_4 = 410^\circ\text{C}$ 

Release temperature of the compressed air from the last grade of the compressor

 $t_2 = 153^\circ\text{C}$ 

Difference of temperature equals:

$$t_4 - t_2 = 410^\circ - 153^\circ = 257$$

It is assumed that approximately 80% of heat of the difference of temperature from  $257^\circ$  are transferred from the escaping gases to the compressed air. The temperature of the escaping gases in front of the pipe becomes

$$t_3 - t_4 = 0,80(t_4 - t_2) = 410 - 0,80 \cdot 257 = 410 - 205 = 205^\circ\text{C}$$

while the temperature of the compressed air not yet fully heated is  $753 - 205 = 368^\circ\text{C}$ ,

Quantity of heat transmitted per hour equals:  $Q = G \cdot (t_4 - t_3) \text{ am} = 9,75 \cdot 3500 \cdot 205 = 1800000 \text{ kJ}/480$

Specific volumes in various places are as follows:

Inlet of escaping gases in the interchanger of heat  $V = 55 \text{ m}^3/\text{kmol}$

Release of escaping gases from the interchanger of heat  $V = 38,8 "$

Inlet of compressed air in the interchanger of heat  $V = 3,26 \text{ m}^3/\text{kmol}$

Release of compressed air from the interchanger of heat  $V = 4,95 \text{ m}^3/\text{kmol}$

The actual volumes for  $G = 975$  kilograms per second of the air weight

Escaping gases at inlet  $V_0 = 18,5 \text{ m}^3/\text{sec}$

$$V_n = 18,5 \text{ m}^3/\text{sec}$$

" " release  $V_0 = 12,4 "$

Compressed air at inlet  $V_0 = 1,1 "$

$$V_n = 1,37 \text{ m}^3/\text{sec}$$

" " release  $1,87 "$

SECRET

Internal combustion turbineInterchange of heatSmoke-gas transfer of heat. Heat change from the side of the compressed gasSmoke-gas heat changeCalculation is based on a mean volume  $V_m$  13,0 m<sup>3</sup>/secSpeed between the pipes becomes  $W_m = 12,5 \frac{18,0}{25} = 8,0$  m/sec

For flowing among the pipes the Rheinhold number becomes

$$Re = W \cdot d \cdot \frac{1}{\mu} \cdot \gamma = \frac{8,0 \cdot 8,038 \cdot 0,508}{0,000000 \cdot 8,81} = \frac{0,000}{0,000029} = 2140$$

Coefficient of the heat change becomes

$$\alpha_1 = \frac{k \cdot Re^{0.62}}{d} = \frac{0,25 \cdot 2140^{0.62} \cdot 0,087}{5,013} = 83 \text{ kcal/m}^2 \text{ per second}$$

Heat change from the side of compressed gas

Calculations made with the average volume of 1.37 cu meters per second

Then the speed becomes  $W = \frac{1,37}{210} = 9,35$  m/sec

and the coefficient of the heat change

$$\begin{aligned} \alpha_2 &= 22,6 \cdot 1 - 0,05 \cdot 0 - 0,18 \cdot (W \cdot p) \cdot 0,79 \cdot b \\ &= 22,6 \cdot 4 - 0,05 \cdot 0,011 - 0,18 \cdot (9,35 \cdot 11) \cdot 0,75 \cdot 0,1075 \\ \alpha_2 &= 22,6 \cdot 0,88 \cdot 2,06 \cdot 38 \cdot 0,1075 = 174 \text{ kcal/m}^2 \text{ per second} \end{aligned}$$

By leaving out of consideration the wall of the pipe, the coefficient of the heat transfer

is calculated from  $\frac{1}{k} = \frac{1}{\alpha_1} + \frac{1}{\alpha_2} = \frac{1}{83} + \frac{1}{174} = 0,012$   $k = 57 \text{ kcal/m}^2 \text{ per second}$ Difference in temperature is  $t_m = 48^\circ$ 

Interchanger of heat with 580 sq meters heating surface transmits per hour

$$Q = F \cdot k \cdot t_m = 580 \cdot 57 \cdot 48 = 1800000 \text{ WE/second}$$

As against the calculated quantity of heat for interchange with 1800000 WE/per hour

200000 WE are short, so that instead of 80% only 78% of heat quantity are transmitted.

SECRET

Internal combustion turbine

Interchanger of heat

Transfer of heat from the side of compressed gas

Resistances in the flow of the interchanger of heat now become:

$$\Delta p = \eta \cdot \frac{W^2}{2g} \cdot 48 \cdot 0.33 \cdot 0.608 \frac{8^2}{2} = 31 \text{ kl} / -2-0.0031 \text{ atmosphere}$$

$$\text{The side of the compressed air } \eta = \frac{1.0}{\rho} = \frac{31}{0.608} = 51 \text{ m gas column}$$

with the other resistances of the current of approximately 85 meters of gas resistance

the total loss becomes  $51 - 35 = 140 \text{ m gas column}$ 

$$140 \cdot 0.608 = 85 \text{ kg/m}^2 = 0.0085 \text{ atmospheres}$$

$$\text{The side of the compressed air speed } W = 9.38 \text{ m/sec}$$

$$\rho = 8.1 \text{ kg/m}^3 \cdot \eta = 0.00000297 \text{ kg sec/m}^2 = 981 \text{ m/sec}^2$$

$$Re = \frac{W \cdot d \cdot \rho}{\eta} = \frac{9.05 \cdot 0.011 \cdot 8.1}{0.00000297 \cdot 9.81} = \frac{0.70000}{0.0000292} = 25000$$

Auxiliary magnitude of resistance is equal to

$$\lambda = 0.316 / \sqrt[4]{Re} = 0.316 / \sqrt[4]{25000} = 0.316 / 12.6 = 0.025$$

and the end of resistance due to friction of the pipe

$$\eta \cdot \lambda \cdot \frac{1}{d} \cdot \frac{W^2}{2g} = 0.025 \cdot \frac{10.5}{0.011} \cdot \frac{8.35^2}{19.82} = 106 \text{ m gas column}$$

$$\text{Speed at release from the pipes } 14 \text{ m gas column}$$

$$\text{Resistance of connecting lines, etc } 100 \text{ m gas column}$$

$$\text{Total resistance } 235 \text{ m gas column}$$

When  $\rho = 7.1$  the loss expressed in atmospheres, is:

$$\Delta = \rho \cdot 235 = 1670 \text{ kg/m}^2 = 0.767 \text{ atm.}$$

1983 MCA 13 08 14